

THURSDAY, APRIL 25, 1889.

THE SURFACE OF THE EARTH.

Das Antlitz der Erde. Von Eduard Suess. Mit Abbildungen und Kartenskizzen. Erste Abtheilung, 1883; Zweite Abtheilung (Schluss des I. Bandes), 1885. (Prag: F. Tempsky. Leipzig: G. Freytag.) Zweiter Band. Mit 42 Text-Abbildungen, 1 Tafel, und 2 Karten in Farbendruck. (Prag: Wien. Leipzig: F. Tempsky, 1888.)

THE varied attainments of geographers have enabled them to express emphatic views on the scope of their subject. Each in turn has augmented knowledge of the earth's surface till it has become difficult to distinguish the contributions of mathematician and astronomer, physicist and physical observer, geologist and naturalist. Many geologists have been eminent as geographers, and Lyell and Humboldt gave the subject an enduring scientific importance by teaching the effects of geological causation in shaping the earth's surface. Every geologist is aware how the light of geological structure illuminates the problems of mountain form, position, and relation to surrounding land; but never till now has an author attempted to narrate the geographical story and history of the earth's surface from a geological point of view. Prof. Suess has brought to the subject the qualifications of a great teacher, who realizes that science has a duty to make itself available to the unlearned, no less than to aid the researches which are yet to be made; and he has conceived of the earth's surface in a new, forcible way, which stimulates alike imagination and thought, and lays before the reader a wide knowledge of fact. This work, which we know has occupied the author for the past twelve years or more, can scarcely be judged of as a whole, because the third volume, whose subject gives a title to the treatise, is unpublished; but we may say that a more luminous and profound endeavour to place the elements of scientific geography before the general reader has not been made. We may perhaps think the subjects discussed need the aid of more figures to enable the reader to think as the author thinks, and attain a similar command of his facts. The aim of the work is to lead the reader through a consideration of the movements in the outer layers of the earth's crust which are manifested at the present day, and in the first half of the first volume the more striking phenomena are narrated, which are associated with volcanic disturbance and earth movements. The second part of the volume examines the structure and construction of mountain chains. The author naturally takes the Alpine system first, as nearest to the Austrian people, and then treats of the depressions, like the Adriatic and Mediterranean, associated with the prolongations of the Alpine system. Successive chapters tell the story of the mountain structure of Southern Africa and the Sahara, of Central Asia and the Malay Islands, and of the mountain systems of America and the West Indies. Thus, by raising the mountain chains, the author leads up, in the final chapter of the first volume, to a discussion of the nature and origin of continents, no less than of their relations to the seas from which they emerge.

VOL. XXXIX.—NO. 1017.

The introduction is an introductory lecture, not written like a syllabus, for that is given in the table of contents, but designed to introduce the reader to conceptions of a large kind on which the scientific aspects of geography are based. The distribution and forms of land masses and depths of the oceans are shown to be effects of movements of the earth-rind which have varied through successive geological ages and so changed the distribution of life.

The work begins with an exposition of the Flood and ancient Babylonian cosmogonies, and the author states that the Deluge was connected with the lower Euphrates and flooding of the low land of Mesopotamia, owing probably to an earthquake combined with a cyclone from the south. The interest of the unlearned reader is thus insured. An excellent account is given of earthquake phenomena, followed by a chapter on "Dislocations," which are defined as resulting from decrease in the volume of the earth, and as comprising horizontal and vertical movements. The crumpling, contortion, and folding of the rocks of mountain masses is classified as consequent on tangential thrust, sinking, and the combined effects of these actions. Volcanic phenomena occupy the next chapter, and are regarded as dependent on the formation of radial fissures. These general studies completed, we turn in the second part of the first volume to the mountains of the earth. The Russian table-land is described as consisting of granite in Finland, on which rest Silurian and Devonian, and successively newer rocks stretching under the Carpathians; but it is uncertain whether the newer rocks of this plain extend under the Bug. The Sudetic Alps are described as closely linked in origin with the Russian table-land and the Carpathians. The Franconian-Swabian basin follows, and leads to a discussion of the system of the Alps, which is regarded as beginning with the Carpathians, as curving south with the Jura, being prolonged south-east with the Apennines, and then continued west through North Africa to the pillars of Hercules. The plain of Hungary is compared to the eastern half of the Mediterranean. The Adriatic basin is closely connected with the Plain of Lombardy, both being defined by the Apennines, which, though at one time independent of the Alps, have now become connected with them. These mountains rise in an unbroken, steep curve facing those depressions, and looking like an outer border of the Alps thrust up above the level of the deep-lying basins. The history of the Mediterranean Sea is illustrated by the newer Tertiary deposits and the life which they contain. At first the sea reached the central plateau of France, the valley of the Rhone, Styria, Switzerland, Hungary, and Transylvania, stretching east to the source of the Euphrates and Northern Persia. The second phase of the Mediterranean was excluded from Switzerland and the valley of the Danube, and extended over the Russian plateau to Kherson and into Asia Minor. Later still it filled the valley of the Rhone, and approximated to its present outline, being excluded from Asia Minor; but the Ægean Sea was a fresh-water lake. The distribution of these deposits in North Africa is shown by means of a map in the chapter on the Sahara and Egyptian deserts; and evidence of the antiquity of the fauna of the Nile is found in the distribution of its life in Syria and Arabia. The

D D

author now passes to South Africa, the Indian peninsula, and Madagascar, which have the characters of a table-land which was once continuous, and from their geological history the sediments are derived which constitute the Cretaceous and Tertiary rocks of the Sahara and Arabia. The high land to the north of India is fully described, chain by chain, in the details of geological structure which govern their forms and continuity, leading to the volcanic regions of Java and Sumatra. There appear to be four great curves southward, seen in the Iranian chain, Hindu Kush, Himalayas, and the Malayan chain. The connection between the mountains of Central Asia and Europe is traced on the basis of the distribution of Tertiary strata: all the European mountains are regarded as continuations of chains which extend from the Thian Shan group. The continuity here sought to be established would appear to depend not less on the evidence of denudation than upon stratigraphical proofs of contemporary folding. The author, for example, carries the line of Cyprus through Crete into the Dinaric Alps, while the chain of the Caucasus passes through the Crimea and Balkans by Ovsova into the Carpathians; but these curved lines seem to us rather the results of denudation of folded rocks than an indication of the directions in which the lines of folding were prolonged.

Three chapters are devoted to North and South America and the West Indies, treating of the rock-structure and folding of the earth-rind in the same way as in other parts of the globe. The rind appears to the author as more plastic or more symmetrically bent than we have been accustomed to regard it, inasmuch that he everywhere finds the chains curved, whereas we often find them extending at angles to each other. The volcanoes of the West Indies are found to have the same relation to the main chain as have those of the Apennines and Carpathians, being on the inner side of the arch. And the Caribbean Sea is further compared with the western part of the Mediterranean.

The second volume is devoted to the oceans, and commences with an historical account of views held by successive investigators on the displacement of the shore-line. Three lines of investigation suggest themselves: first, the changing distribution of the seas in successive periods of time, which may be furnished by evidence of shore-lines and sea-margins; secondly, by comparing the areas of deposition of sediments in past time, some idea is obtained of the ancient oceans; and thirdly, by studying existing shores, evidence is found of oscillations in level. Beginning with the great waters of the present time, a detailed history is given of the Atlantic. Its shores are described, especially in the northern regions, and the mountains which extend towards the European coast are traced, and said to be paralleled by chains on the other side of the Atlantic, so that the old rocks of Ireland, Cornwall, and Brittany, appear to extend beneath the ocean. The west coast of Africa, and shores of Central and South America, are similarly described and compared in the light of their geological structure. The *Serro do Mar* in South America is regarded as comparable with the Appalachian chain, and hence it follows that the entire American continent is the consequence of a tangential thrust towards the Pacific Ocean. The history of the Pacific Ocean begins with the shores of New

Zealand and Australia, but the author avails himself of the fossil floras and other evidences to indicate ancient relations of the strata with the corresponding rocks of Europe, India, and other localities. The line is followed on through New Ireland, New Caledonia, Borneo, Coch'in China, Tonquin, the Philippines, and Japan, and so by the Kurile and Aleutian Islands to the west coast of America, everywhere dwelling on the light thrown by the geological structure of those countries upon the variations in extension of the sea. The Atlantic and Pacific are compared with each other, and found to have many points of structure in common. The foregoing evidences of change in ancient oceans furnished by the rocks seen on their borders, necessitate a history of geological changes in the Palæozoic, Mesozoic, and Tertiary periods of time. In a chapter on Palæozoic oceans, it is stated that they make us aware of two continents which now only remain in fragments. The first occupied the North Atlantic Ocean, furnished the ancient sediments of Europe and America, and its remains persist as Greenland. The second continent is first recognizable at the end of the Carboniferous period. Its relics persist in Africa, India, and Australia. As the former is known as Atlantis, so the latter is named Gondwanaland. No seas of the Mesozoic period have left sediments which indicate great depth of water. The chalk alone may be evidence of a deep ocean, which stretched from Europe towards the West Indies in a yet earlier time. Towards the close of the Cretaceous period the seas became smaller. In North America the prairie lands from Canada to Texas and Alabama emerged from the water, and similar upheaval is seen in Europe, and especially evidenced in the freshwater strata of the Pyrenees and Southern France, which make a transition from the Cretaceous to the Tertiary, like that shown by the Purbeck beds in early strata.

These earliest shallow conditions in Tertiary Europe were succeeded by a central sea which reached far to the east, and is estimated to have spread from London to Khartoum, and from Kiew to the Indian Ocean. And the author sketches with a bold hand the succession of physical conditions changing the breadths of water which have resulted in the contours of existing shore-lines in America and the Old World.

Evidences of the changes which have occurred in the contour of existing shores are found in detailed study of the coasts of Norway, and the inland terraces, which mark earlier extent of the sea and glacial action. Other evidences of instability of the shore-line are recorded with similar detail on the coasts of Italy. And the history of the Baltic and North Sea emphasize the mutability of shores. The historical records of the Mediterranean shores supply, especially in its eastern parts, striking proofs of oscillation in Greece, Syria, Egypt, and Asia Minor. The northern shores of the world supply many proofs that at the close of the Glacial period the shoreline was more elevated than it is now. An examination of the shores of the equatorial and southern seas demonstrates the former wide spread of deposits in which the life is substantially the same as in the nearest oceans, though there is sometimes, as in South America, a larger number of European species.

Finally, a summary is given of the characteristics and geological history of the oceans which have been de-

scribed. The southward direction of peninsulas is attributed to folding of the earth's crust, and to depression of the ocean floor, which has caused the water to predominate towards the south, so that they are always in relation to areas of depression. It will thus be seen that, in simplicity of conception, largeness and continuity of the ideas dealt with, amplitude and detail of the knowledge and inductions brought together and correlated, this work promises to be one of the most valuable contributions to the history of the earth which we possess. From the time when Godwin-Austen planned his work on the ancient physical history of Europe which geology supplies, data have been accumulating with a rapidity which has made the task almost hopeless, of writing a history of the earth's surface which should be at once exact in details and large in ideas. But Prof. Suess does not so much trench on geological history, which can only be told intelligibly when supported by masses of technical facts; for his aim is to impart vitality to learning and teaching of those phenomena with which the geographer is concerned. It may be too much to say that he attempts to do for the surface of the earth what Darwin did for the distribution and classification of life, because so much had been previously contributed with which his own work is in perfect harmony; but we may say that henceforth no geographical teacher can neglect to place before his pupils the methods and results which the author's work brings to his hand. And we may anticipate that much as Lyell's treatise, the "Principles of Geology," has laid the firm foundations of geological thought and of scientific observation in geographical science, so this treatise appears likely to mark a similar epoch in the history of geography, becoming a guide to its principles for students and readers.

It is significant that it is the outcome of long experience, first as Professor of Palæontology, then as Professor of Geology, on the part of one who has given many of the best years of his life to the endeavour to make practical application of geological knowledge in improving water-supply and navigation of the earth's surface which surrounds Vienna. The same thoroughness and devotedness with which these earliest of his public works were done are seen in this latest contribution to education; and we cannot but see that geography, as Prof. Suess teaches it, is a science based upon the sciences which he has himself professed, though expanding in its ultimate developments to include that knowledge which the naturalist and the observer of Nature record. Every chapter is followed by a long bibliography, in which the reader finds the more important original sources of information with which the writer has refreshed his memory; and the beautiful drawings and engravings scattered through the volumes will be not less welcome to the earnest student as presenting typical examples of the geological foundations of geographical truths seen on the earth's surface.

H. G. SEELEY.

NATURAL INHERITANCE.

Natural Inheritance. By Francis Galton, F.R.S. (London: Macmillan and Co., 1889.)

IT is related that, when some boastful patriot was once describing the trees in his country as so high that a man could hardly see their tops, a stranger retorted.

"That is nothing to the trees in my country, which are so high that two men are required to see the top of them; one man looks as far as he can, and the other begins where the first stops." A similar division of labour would be required in order to survey adequately the imposing scientific edifice which Mr. Galton has constructed; based as it is on a foundation of geometrical reasoning, and culminating in the clouds of biological hypothesis. The parts which are nearest to *terra firma* are most within our ken. The mathematical foundation and the structure which rests immediately thereupon appear to us solid and elegant. The author has restated the law of error in a form adapted to sociological investigations. He says truly and happily:—

"This part of the inquiry may be said to run along a road on a high level, that affords wide views in unexpected directions, and from which easy descents may be made to totally different goals to those we have now to reach."

Mr. Galton reads a useful lesson to statistical practitioners, when he complains that they limit their inquiries to averages, without taking account of those deviations from the average which are the subject of the theory of errors.

"Their souls seem as dull to the charm of variety as that of the native of one of our flat English counties, whose retrospect of Switzerland was that, if its mountains could be thrown into its lakes, two nuisances would be got rid of at once."

Mr. Galton is not dead to the charms of "normal variability." Statistical theory illustrated by him becomes in a high degree fascinating:

"Not harsh and crabbed as dull fools suppose."

He may well say:

"Some people hate the very name of statistics, but I find them full of beauty and interest."

Some of his riders on the law of error may be interesting even to physicists. The following problem is not so familiar to astronomers, but that Mr. Galton's solution of it may deserve attention. Given three or four observations relative to an unknown quantity; and again another small group of observations made on some other quantity by the same instrument or method of observation; and so on, each of the different little groups not in general comprising the same number of observations: find from the residuals, or apparent errors, presented by the respective groups, the true "probable error" incident to the method of observation. Mr. Galton gives four solutions of this problem, of which two involve data which are special to his subject; two may be described as general. Neither of the latter coincides with the theoretically best possible method; but the consilience of their results with each other and with the other two methods is interesting.

We have worded the problems in terms of *errors*. The form in which it presents itself to Mr. Galton relates rather to the deviations of individuals from their common type. He is determining the "probable error" or dispersion of the heights of brothers compared with their mean. It proves to be much less than the corresponding constant for the adult population generally. The question arises in the course of an inquiry whether the mean height of brothers and sisters deviates from the general average of adults less than the height of their parents. There is a little difficulty in stating the question